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## Compact diversity antenna for UHF RFID readers

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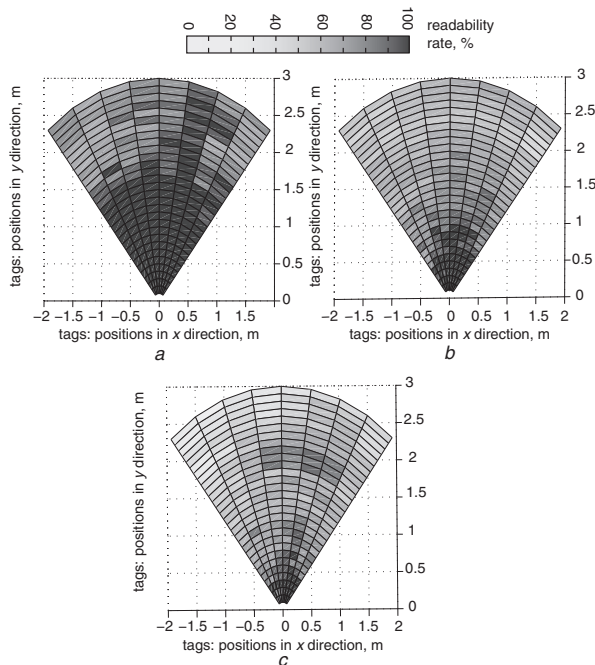
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against the distance between the cardboard box and the reader's antenna and its azimuthal angle from the antenna centre. The cardboard box is then moved in the test zone using 10cm radial steps and  $10^\circ$  angular steps (270 measurement samples). The measurements were made in a lab room dominated by the presence of numerous metallic objects (cabinets, measurement equipment) and concrete walls. The cardboard box and the reader antennas are placed 1.1 m above the ground floor. Each of the four IFA ports are connected through coaxial cables to one of the four output channels of the RFID reader Impinj's Speedway R420 [8]. The reader then sequentially switches between the IFAs. In a commercial version, the antenna should be fed by a SP4T connected to one of the reader outputs. The reader delivers 29 dBm to each IFA element which results in a EIRP (equivalent isotropic radiated power) of  $29\text{dBm} + 5\text{dB} = 34\text{dBm}$ . The tags readability with the diversity antenna is compared with a 7 dBic circularly-polarised antenna (Poynting PATCH-A0025  $24.5 \times 23.5 \times 4\text{cm}$ ) and a 5 dBi linearly polarised antenna (IMPINJ-A0311-USA  $46 \times 9 \times 2\text{cm}$ ). For a fair comparison, reader output powers are adjusted so that identical EIRPs are obtained for each antenna.

Fig. 4 shows the rate of tag readability in the test zone for the three reader antennas: diversity antenna (Fig. 4a), CP antenna (Fig. 4b) and LP antenna (Fig. 4c). As shown in Fig. 4a, 100% of the tags have been read by the diversity antenna up to 1.5 metres. Beyond this distance, the rate of tags readability remains above 70% in the measurement area. When the reader is connected to the CP antenna the 100% reading range is shorter, about 1 metre (Fig. 4b). This readability rate decreases when the cardboard box moves away from the reader. With the CP antenna only 10% of the tags are read at 2 metres compared with more than 80% with the diversity antenna. Unlike the two other antennas, a fluctuation of tags reading with distance is observed for the LP antenna, as illustrated in Fig. 4c. Two hot zones where 80% of the tags can be read are identified: the first is below 0.70 from the reader and the second at approximately 2 metres. The reading rate does not exceed 40% elsewhere. The second reading spot at 2 metres is attributed to multipath in-phase combination. These fluctuations are not observed with the diversity antenna where the tag readability rate decreases continuously along the distance. In any case, the reading rate is much larger for the diversity antenna than the two others.



**Fig. 4** Tags readability test  
a Diversity antenna  
b CP antenna  
c LP antenna

*Conclusion:* A compact diversity antenna is developed to enhance the readability for a strong density of passive UHF tags in indoor scenarios. By combining space, pattern and polarisation diversities, the proposed antenna offers better reading rates than available commercial RFID reader antennas for equivalent volumes. Associated to an integrated SP4T, and added to classical RFID techniques for reading improvement such as the displacement of the tagged objects and/or the multiplexing of several reader antennas at distant points, the proposed antenna should make possible a convergence to a 100% reading rate much faster than the existing antenna solutions.

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One or more of the Figures in this Letter are available in colour online.

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